Population biology of *Euptoieta hegesia* (Nymphalidae: Heliconiinae: Argynnini) in an urban area in Southeastern Brazil

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Abstract. A population of the heliconiine butterfly *Euptoieta hegesia* was studied during 15 months on the campus of the Campinas State University, SE Brazil. The data revealed a small and unstable population. The number of individuals captured per day varied from one to 10. The sex ratio was female biased. Age structure was relatively stable throughout the study, with a shift in dry season related to the low number of individuals. Average residence time was of three days for males and one day for females, with a maximum of 14 days for males and three days for females. The average forewing length of females (31.7 mm) was significantly higher than the average forewing length of males (30.5 mm). *Turnera ulmifolia* was the most common nectar source during the study. The results suggest that the individuals sampled in the study area are only part of a larger and more widely distributed population.

Key words: *Euptoieta hegesia*, mark-recapture, Nymphalidae, *Turnera ulmifolia*, urban ecology.

Introduction

Although the recent surge of interest in conservation of tropical environments has led to an increase in studies of natural history and ecology of tropical organisms, there remain few population studies of butterflies to date. Most studies have dealt with species of Heliconiinae, Ithomiinae (Nymphalidae) and Troidini (Papilionidae) in forested areas (Freitas, 1993, 1996; Pinto & Motta, 1997; Ramos & Freitas, 1999; Freitas & Ramos, 2001; Freitas *et al.*, 2001; Andrade & Freitas, 2005). Few studies have been made in open habitats (but see Schappert & Shore, 1998; Vanini *et al.*, 1999).

The Heliconiinae (Nymphalidae) are a well-known and of considerable evolutionary interest, with mostly studies concentrated in the tribe Heliconiini (Turner, 1971; Ehrlich & Gilbert, 1973; Cook *et al.*, 1976; Araujo, 1980; Mallet & Jackson, 1980; Brown, 1981; Ehrlich, 1984; Romanowsky *et al.*, 1985; Mallet, 1986; Quintero, 1988) by comparison with the other tribes (e.g., Schappert & Shore, 1998; Francini *et al.*, 2005)

Euptoieta hegesia (Cramer, 1779) belongs to the tribe Argynnini, subfamily Heliconiinae (following Freitas & Brown, 2004). *E. hegesia* ranges from Mexico to Argentina and the Caribbean islands, occurring in open habitats from sea level to 1200 m (DeVries, 1987). Its main larval host is *Turnera ulmifolia* L. (Turneraceae), an herbaceous weed with ephemeral flowers common to roadsides and open landscapes (Barret, 1978; Barret & Shore, 1987). Alternative host plants have been recorded (DeVries, 1987; Schappert & Shore, 1998). The only published study on population biology is the work of Schappert and Shore (1998) in Jamaica. Although their study included information on the biology of *E. hegesia* in nature and captivity, it dealt with an insular population of a restricted geographic range.

Our study describes population parameters of *E. hegesia* in an open urban habitat in southeastern Brazil, and compares them with other Neotropical butterfly species.

Study site and methods

The study was carried out on the campus of the Universidade Estadual de Campinas (Unicamp), state of São Paulo, southeastern Brazil. The study is part of a project on urban ecology at University Campus (see also Vanini *et al.*, 1999; Cogni *et al.*, 2000 and Dutra & Freitas, in prep.). Annual rainfall is 1360 mm and average temperature is 20.6°C ("Instituto Agronômico de Campinas"). The regional climate is seasonal, with a warm wet season from September to April and a cold dry season from May to August. During the period of study the average temperature of the coldest month

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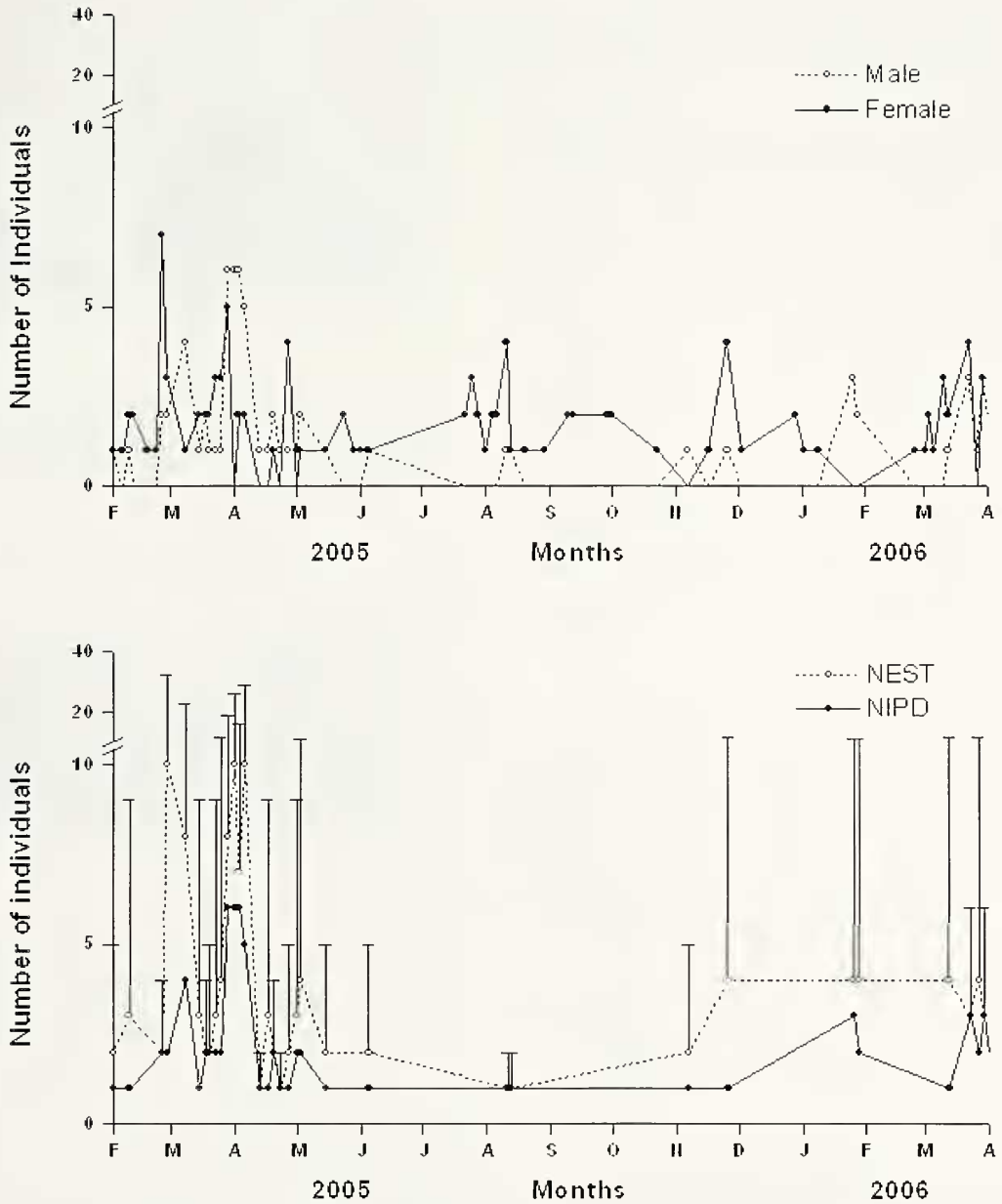

Figure 1. Above, number of males and females of *E. hegesia* collected from February 2005 to April 2006. Arrows indicate mechanized grasscuttings. Below, population size (males only) of *E. hegesia* as number of individuals present per day (NIPD) and Lincoln-Petersen estimates, from February 2005 to April 2006. Arrows indicate mechanized grass cuttings (for both pictures). Vertical bars = standard error.

was 18°C and of the warmest month was 24°C.

The study site is a typical University campus habitat, composed of wide lawns with sparse trees and scattered small flowering shrubs, separated by buildings and streets. Lawns were mowed by campus crew five times during the study period (10 II 2005, 17 IV 2005, 26 VIII 2005, 28 IX 2005 and 8 II 2006).

Population parameters were estimated by mark-release-recapture (MRR). Butterflies were netted, numbered on the underside of one forewing with a felt-tipped pen, and released at the point of capture. Sex, wing length and place of capture were recorded for each. Marking provided estimates of population size and individual movements (Cook *et al.*, 1976; Turner, 1971; Freitas, 1993, 1996; Ramos & Freitas, 1999). Forewing length was measured to the nearest millimeter with a ruler. Age was estimated visually and recorded using a three category system (new,

intermediate and old) modified from Ehrlich and Davidson (1960), Brussard and Ehrlich (1970) and Ehrlich and Gilbert (1973).

Butterflies were captured from 8 II 2005 to 12 IV 2006, 1-3 times per week, for a total of 67 field days. Marking sessions were conducted with 1-2 persons for about two hours and always between 0830 h and 1330 h.

MRR data were analyzed by the Lincoln-Petersen method, with Bailey's modification for estimating population parameters of population size and standard errors, using CMLR software developed by Dr. R. B. Francini, Unisantos.

Daily results are presented as "number of individuals present per day" (NIPD), with recaptured individuals considered as present in the population over all previous days since the day of first capture (= risk marked animals, as in Ramos & Freitas, 1999 and Vanini *et al.*, 1999). Residence time was estimated following Brussard *et al.* (1974). Sexes were analyzed separately in most cases.

Results

Population biology. A total of 159 individuals of *Euptoieta hegesia* (50 males and 109 females) were captured between February 2005 and April 2006, with 23 of these recaptured one or more times. The number of individuals captured per day varied from 0 to 7 (mean = 1.94; SD = 1.71; n = 67) for males and from 0 to 7 (mean = 1.72; SD = 1.31; n = 67) for females (Fig. 1). The estimated number of males present per day varied from 1 to 10 (mean = 3.79; DS = 2.63; n = 33) (Fig. 1). The population (based on individuals present per day) peaked during March and April 2005.

Sex Ratio. Sex ratio was highly female biased (X2 = 21.89; DF = 1; P < 0.0001), with the proportion of males to females changing over the months (Fig. 2). All recaptured females (n = 6) were recaptured only once, while males were recaptured up to three times (n = 17). The proportion of males recaptured (39.5%) was significantly higher than of females (5.5%) ($\chi 2$ = 22.49; DF = 1; P < 0.0001).

Age structure and residence time. The age structure of the population remained stable during the study (Fig. 3). However, there was an increase in the proportion of older individuals in May versus intermediate ones, reaching approximately 50% of the total individuals. In February and March of 2006 there was a peak of new individuals, corresponding to 58% of the sample. The average estimated residence time for males was three days (maximum of 14 days) and for females was one day (maximum of three days).

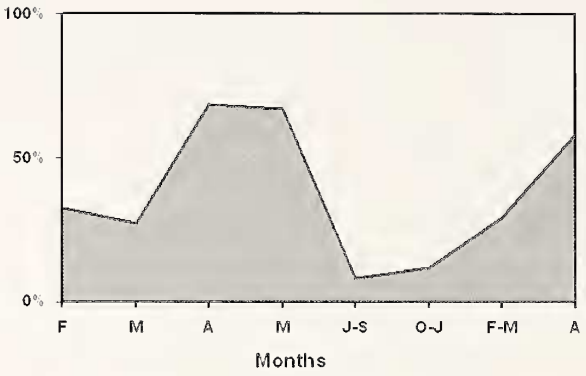

Figure 2. Sex ratio of *E. hegesia* represented by the percentage of males from February 2005 to April 2006.

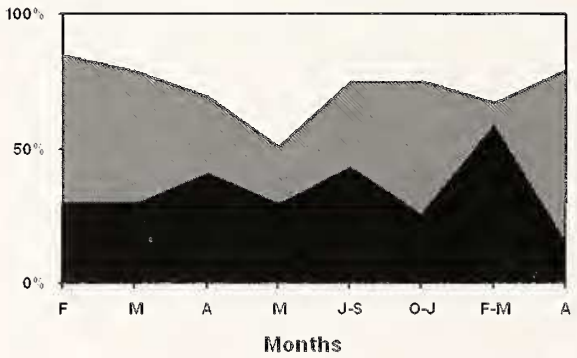

Figure 3. Age structure of individuals of *E. hegesia* from February 2005 to April 2006. Black = new; gray = intermediate; white = old individuals.

Wing size. The average forewing length of females (32.4 mm, SD = 2.22, n = 106) was significantly longer than of males (31.7 mm, SD = 1.85, n = 49) (t = 3.51; DF = 155; P < 0.001) (Fig 4). The variation of wing size through the year suggests a reduction in the size of the individuals after April of 2005, rising again between October of 2005 and January of 2006.

Resource. *E. hegesia* was observed visiting four different nectar sources during the study: *T. ulmifolia* (Turneraceae), *Tridax procumbens* L., *Emilia sonchifolia* (L.) DC. (Asteraceae) and *Lantana camara* L. (Verbenaceae). Of 68 records, 59% were on *T. ulmifolia* and 34% on *T. procumbens* L.

Discussion

Contrasting with populations of *Heliconius* that maintain relatively constant numbers throughout the

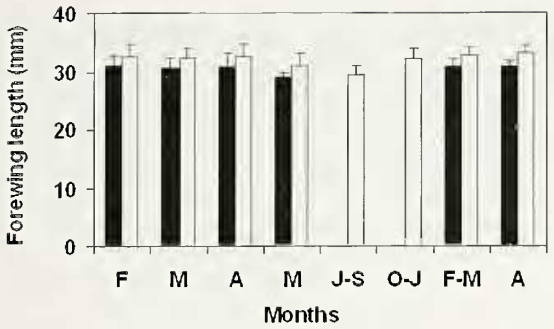

Figure 4. Average forewing length of males and females of *E. hegesia* from February 2005 to April 2006. Vertical bars = standard deviation. Black bars = males; white bars = females.

year (Turner, 1971; Ehrlich & Gilbert, 1973; Araujo, 1980; Ramos & Freitas, 1999), the results for *E. hegesia* suggest an unstable open population at the study site. Even with the proportion of recaptured males relatively high, females were seldom recaptured and appeared to have flights of long range, suggesting that the individuals in the study area were only a fraction of a larger and more widely distributed population. Lawn mowing during the study period appeared correlated with a reduction in number, as was observed in April. Lawn mowing eliminates immatures and most of the adult food sources. The effect may in turn have caused dispersion of adults to neighboring habitats, producing the abrupt reduction of butterfly number observed. Since lawn mowing occurs across the entire Campus and in urban lots, adults can re-colonize the study area coming from these neighboring sites when resources are also there eliminated. Mowing may accordingly explain the abruptly variation in butterfly numbers and the inconstant population pattern found. A similar pattern was observed in *Eurema elathea* (Cramer, 1777) (Vanini *et al.*, 1999).

The preponderance of female captures contrasts with the usual male-biased captures in field studies with butterflies, including *E. hegesia* itself (Brussard & Ehrlich, 1970; Freitas, 1993, 1996; Schappert & Shore, 1998; Ramos & Freitas, 1999; Freitas & Ramos, 2001; Freitas *et al.*, 2001; Vanini *et al.*, 1999; Andrade & Freitas, 2005). Male biased sex ratios are usually explained by differences in behavior between the sexes, with males flying in the same places as collectors, the trails with nectar resources (Freitas, 1996; Ramos & Freitas, 1999). When this collecting bias is removed, sexes may be sampled in proportion to their actual occurrence in natural habitats, for example using bait traps (Uehara-Prado *et al.*, 2005; Uehara-Prado & Freitas, 2008) or by sampling the entire area where adults occur, as in the present study where there is no place to hide.

Age structure remained constant throughout the period of study, indicating the lack of a specific recruitment time. However, the apparent "aging" of the population observed during May 2005 may indicate a lower recruitment of new individuals, with the local population sustained by butterflies born the prior month. The maximum observed lifespan supported the study of Schappert and Shore (1998).

Schappert and Shore (1998) also noted that females were significantly larger than males. Although the observed variation in wing size for both sexes was low, the smaller average values observed from May to September may correlate with changes in the nutritional quality of larval foodplants. When the rainy season begins during October and the plants become robust, wing length also increase.

The frequent use of the flowers of *T. ulmifolia* contrasts with the study of Schappert and Shore (1998), who found this nectar source not commonly used by *E. hegesia*. In our study, *E. hegesia* appears to use all available flowers across the study site as food, which is likely a consequence of few alternative nectar sources and high prevalence of *T. ulmifolia* across the study site. The same pattern of nectar use of was found to *E. elathea* in the same area (Oliveira, 1996).

In the literature, no general pattern is revealed with butterfly species in open habitats. Thus population structures can be different in different populations of the same species as well as in the same population in different years (Ehrlich, 1984). In some species of nymphalids, for example, population structure may vary among local populations occurring in discrete demographic units (Dowdeswell *et al.*, 1957; Brussard *et al.*, 1974) to open populations spread over wide areas (Brussard & Ehrlich, 1970). In our study area, the instability of larval and adult resources caused by of the periodic mowing of the lawns may force the high vagility of adults and may at the same time also select more mobile individuals. The result explains the large, open, and widespread population in the study area and neighboring landscapes.

A broader study program, with additional labor and multiple sites around the study area, would be necessary to clarify the regional pattern of population dynamics in the region. Moreover, the interaction of these results with other ecology studies done on the campus would be useful to establish a more rational policy of handling green areas of the campus, aiming for maximizing biodiversity. The latter is an obvious indication of the health of urban ecosystems with maximal biodiversity the goal (Brown & Freitas, 2003).

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